U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
NO. HE 79-146-670

CINCINNATI COLLEGE OF MORTUARY SCIENCE
EMBALMING LABORATORY
CINCINNATI, OHIO

MARCH 1980

I. SUMMARY

A Health Hazard Evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) on October 2, 1979 at the Embalming Laboratory of the Cincinnati College of Mortuary Science to determine if chemicals used during embalming operations were presenting a potential exposure problem. The request was prompted by the early disability retirement of an embalming instructor who had developed asthmatic bronchitis after five years of laboratory exposure.

Environmental samples were collected, via general area and personal sampling techniques, during simulated embalming ("worst case") and actual work conditions to determine worker exposure potentials. In addition, ventilation measurements were obtained to determine the efficiency of the existing exhaust and supply system. The medical part of the evaluation consisted of personal interviews, and where applicable, consultation with the employee's physician.

Analysis of environmental data indicate no phenol overexposure. Formaldehyde, on the other hand, was detected in various concentrations. The afternoon the exhaust systems were not in operation, all levels exceeded the present NIOSH recommended 30-minute ceiling of 1.0 part per million parts of air (ppm). Additionally, two of the five samples collected that same afternoon exceeded the current legal (OSHA-3.0 ppm) 8-hour standard.

Medical findings indicate positive histories of allergies (hay fever) among most of the full-time employees. All employees indicated suffering from one or more symptom(s) such as: burning eyes and nose, lacrimation, cough, headache, and dryness of the mouth and throat while embalming heavily decayed corpse(s). Such conditions require increased use and concentration of embalming fluids including formaldehyde.

On the basis of the data obtained in this investigation, NIOSH has determined that a hazard from overexposure to embalming chemicals, including formaldehyde, at the Cincinnati College of Mortuary Science, did exist during the time the exhaust system was not operating at full potential.

Accordingly, recommendations along with a discussion of the ventilation system have been incorporated into the report as a guide for the control of potential or increased exposures that result from embalming operations.

II. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the Director of the Embalming Laboratory on September 17, 1979. The request alleged that employees and students at the lab were being exposed to embalming materials that could result in bronchitis and/or other serious lung or dermatitis problems. Three of the substances identified by the requestor as being emitted during most embalming operations were formaldehyde, paraformaldehyde and phenol.

III. HEALTH HAZARD EVALUATION

A. Facility Description

Cincinnati College of Mortuary Science was originally started in 1882. The Arts and Science Building, which houses the embalming lab, began operations in 1933 with a facility of three full-time and 8 to 10 part-time employees. In 1973, a new addition for embalming services was added to the building which now employs four full-time employees. There were no medical, industrial hygiene, or safety programs in force at the facility during the time of the survey. However, 3-M disposable face masks were supplied to and donned by all persons working in the embalming area.

Embalming operations are performed on three tables located in the center of the laboratory (Table I). Embalming fluids are stored on the north wall in a series of cabinets. Most fluids consist of formaldehyde, phenol, unidentified preservatives, ketone, and ester solvents. Fluids are mixed with water prior to use in injector systems which are located at the south end of each table.

For purposes of the initial hazard(s) evaluation, an attempt was made to simulate worst condition-type situations rather than "normal." In so doing, 1 1/2% Emil Solution (35% formaldehyde-Vol., 34.7% esters plus inert compounds), was mixed with two gallons of water and injected down the surfaces of two tables simultaneously, thus simulating two concurrent embalmings of autopsied bodies. In effort to simulate treatment of the more decomposed bodies, an operating table was painted with phenol and paraformaldehyde powders. In addition, solute qualities of concentrated-37 index (formaldehyde solution) was poured onto a cotten cloth to simulate surface treatment of a partially-decomposed body. All materials remained on the tables for approximately 30 minutes. The tables were then scrubbed with detergent (solution base) and washed down with water. Dissoluble materials were flushed through recepticles and into the city sewage system.

Actual embalming operations were monitoried during a 2-day follow-up hazard(s) evaluation. A greater number of bodies than usual (six) were embalmed the first day. It was noted during the visit that the ventilation system was not functioning. Such a condition would allow airborne contaminants to accumulate, thus exposing the worker(s) to increased exposure potentials. The second day's embalmings were performed while the exhaust system was in operation. Since only two bodies were treated, and the exhaust system was operating, that day's work activities were considered normal.

B. Evaluation Method

1. Environmental Sampling

Both breathing zone (BZ) and general area (GA) air samples were collected to determine formaldehyde and phenol vapor levels. It should be noted that paraformaldehyde is a polymer of formaldehyde and is therefore collected and analyzed as formaldehyde. The formaldehyde samples were obtained for analyses by using charcoal tubes connected, via tygon tubing to sampling pumps calibrated at 200 cubic centimeters per minute (cc/min). MSA personal sampling pumps operating at 1.0 to 1.5 liters per minute (l/m) and connected to a midget bubbler containing 15 ml of 0.1 normal sodium hydroxide were used to collect the phenol samples. Detector tube measurements were also obtained; however, these sampling media were applied as a quick screening technique to determine the presence of formaldehyde and phenol.

2. Ventilation Evaluation

Two distinct ventilation systems are incorporated into the lab design. Two exhaust registers (measuring 18" by 18") are located at floor level on the north wall and connected to a single exhaust fan of 1500 cfm. A 36" by 36" return air register located at floor level on the west wall routes air to a roof-mounted heating and air conditioning unit, where approximately 20% additional fresh make-up air is added, filtered, conditioned, and returned to the lab through ceiling louvers. The air supply and exhaust for this system was determined by using a Kurz* hot wire anemometer and a cardboard adapter duct.

3. Medical

All full-time embalming employees, as well as a student in training, were interviewed via medical questionnaires. The retired embalming instructor, having asthmatic bronchitis, was interviewed by phone. Additional information was obtained from his family doctor and pulmonary specialist, which included copies of medical records.

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* Mention of commercial names does not constitute a NIOSH endorsement.

C. Evaluation Criteria

Evaluation Toxicology

Formaldehyde - HCHO, a colorless, pungent gas produced commercially by the catalytic oxidation of methyl alcohol. The current legal (OSHA) permissible exposure limit is set at 3 ppm for an 8-hour time-weighted average (TWA).[1]

Formaldehyde gas may cause severe irritation to the mucous membranes of the respiratory tract and eyes. The gas has recently been proven carcinogenic in animals.[2] Morrill[3] found sensory irritation (itching of eyes, dry and sore throat, increased thirst, disturbed sleep) in paper process workers at 0.9 - 1.6 ppm. Bourne and Seferian[4] reported from another occupational setting intense irritation of eyes, nose and throat at levels ranging from 0.13 to 0.45 ppm. More recent studies by Kerfoot and Mooney[5] conducted in funeral homes indicated that concentrations from 0.25 to 1.39 ppm evoked numerous complaints of upper respiratory tract and eye irritation and headache among embalmers. Schoenber and Mitchell[6] report that acute exposures to formaldehyde phenolic resin vapors at levels around 0.4 to 0.8 ppm caused lacrimation and irritation of the upper as well as the lower respiratory tract. Taking this into account, NIOSH has recommended a 30-minute ceiling of 1.0 ppm.

The levels at which serious inflammation of the bronchi and lower respiratory tract would occur in man are unknown; inhalation of high levels, however, has caused chemical pneumonitis, pulmonary edema and death.

In humans concentrations of 2 to 3 ppm have caused mild tingling sensation in the eyes, nose and posterior pharynx. At 4 to 5 ppm, the discomfort increases rapidly, and some mild lacrimation occurs in most people. This level can be tolerated for periods of perhaps 10 to 30 minutes in some persons. After 30 minutes have elapsed, discomfort becomes quite pronounced. Concentrations of 10 ppm can be withstood for only a few minutes; profuse lacrimation occurs in all subjects, even those acclimated to lower levels.[10]

Very little is also known about the effects of long-term exposure to low levels of formaldehyde. However, "occupational asthma" due to formalin has been reported at several instances[7,8,9] even in persons who were not known to be atopic. Although the question remains as to whether the illness represents a true hypersensitivity reaction or an acute chemical pneumonitis provoked by formalin, progressive dyspnea and chest tightness accompanied by attacks of wheezing and productive cough seem to be the common feature here. All of these symptoms return to normal after withdrawal within hours or days depending on the exposure dose.

Paraformaldehyde[11] - $HO(CH_2O)nH$ - A polymer of formaldehyde in which n equals 8 to 100. This white solid has a slight odor of formaldehyde and as formaldehyde is soluble in a strong alkali solution. Paraformaldehyde is irritating to the tissue and toxic by ingestion. Exposure problems similar to those of formaldehyde may result when working around increased concentrations of this material.

Phenol - C_6H_5OH - A white crystalline substance with a distinct aromatic acrid odor. The current legal (OSHA) permissible exposure limit is set at 5 ppm for an 8-hour time limit. Phenol has a marked corrosive effect on any tissue. When it comes in contact with the eyes, it may cause severe damage and blindness. On contact with the skin, it does not cause pain but causes a whitening of the exposed area. If the chemical is not removed promptly, it may cause a severe burn or systemic poisoning. Repeated or prolonged exposure to phenol may cause chronic phenol poisoning. This condition is very rarely reported. The symptoms of chronic poisoning include vomiting, difficulty in swallowing, diarrhea, lack of appetite, headache, fainting, dark urine, mental disturbances, and possibly, skin rash. Liver and kidney damage and discoloration of the skin may occur. Phenol can be determined in the blood and/or urine.[12] It is detectable by odor at 0.05 ppm. At 40-50 ppm, it causes marked irritation of eyes, nose and throat. The OSHA TLV is set at 5 ppm (19.2 mg/M^3) to prevent systemic intoxication. Based on reports of irritation, objectionable odor, disturbed sleep for some employees, and general complaints at concentrations exceeding 1 ppm, a ceiling value of 1 ppm (1.2 mg/cm) for formaldehyde in air is proposed by NIOSH as a 30-minute ceiling workplace limit.

IV. RESULTS AND DISCUSSION

1. Environmental sample results and ventilation measurements have been recorded in Tables I, II, and III. As indicated, (Table I) phenol was below the limits of detection (0.4 mg/sample) in each sample.

Formaldehyde, on the other hand, was found exceeding the current 3 ppm legal (OSHA) standard in one area sample (CT-3; 3.99 ppm) during the initial visit. It should be noted that this sample, as well as all other samples obtained at this time, were collected during simulated conditions. Actual embalmings require formaldehyde to be rinsed over the cadaver and instilled into the body cavities and larger vessels for periods of 20 minutes or longer, depending on the condition of the corpse. Accordingly, it was necessary to conduct a follow-up evaluation during objective and/or real conditions. The results from this second evaluation are concluded in Table II. All sample results recorded in Section A of this table are above the NIOSH 1.0 ppm recommended ceiling standard. In addition, two of these samples (M-1, M-3) exceed the current legal (OSHA-3.0 ppm) standard. Important to note from this day's evaluation is that the ventilation

system was not in operation. The results from the 2nd day's follow-up evaluation, Section B (Table II) indicate all levels to be within both the NIOSH Recommended and the OSHA Legal Standards. Ventilation and exhaust systems were maintained and working properly during this day's embalming activities.

Since the increase formaldehyde exposures resulted basically from heavier workloads (increase in number of embalmings) and/or longer time periods to treat the decomposed bodies, it is beneficial that the laboratory's exhaust system be operating and properly maintained.

2. Ventilation

Total air was determined to be 3150 cfm (Table III) using a cardboard duct and a Kurz hot wire anemometer. The 20% make-up air figure was obtained from the maintenance contractor. The contractor also noted that the only air purification provided by the air handling unit was the filtration of large dust particles.

Placement and exhaust volume of the two small exhaust registers (18" X 18") produce no local exhaust effect at any of the embalming tables and therefore served to control vapors (formaldehyde, phenol, etc.) by dilution only. The placement of the large air-return register produced noticeable air movement (smoke tube) at the west table only. No noticeable effects were observed at the other tables. The system is so designed to merely recirculate formaldehyde and other vapors back into the lab. This observation was substantiated by the use of a formaldehyde detector tube "quick screening" method. Levels of approximately 4 ppm were detected at the embalming tables which resulted in concentrations of 2 ppm, being detected at the air supply louvers.

3. Medical

The four embalming instructors, ranging in age from 27 to 37 years, have been employed by the Mortuary Science Institute for a period of three weeks to 13 years. Their work schedules fluctuate and involve 8, 12, 21 and 50 hours per week.

Three of the four instructors have positive histories of allergy (hay fever). Of those who smoke, two are seasonally affected by allergies. None of the four complained about work conditions or felt irritated by chemicals used during embalming operations. However, when questioned in detail, all mentioned suffering from symptoms which developed while treating heavily decayed corpse(s). Such symptoms include,[13] burning eyes and nose, dryness of mouth and throat, cough, headache, and lacrimation.

The student assisting in his off-time, works from a small enclosed office adjacent the preparation area. He, therefore, has a lesser exposure potential than the persons working in the embalming laboratory. No complaints were expressed by this employee.

The retired instructor who was 30 years of age worked approximately 27 hours per week for a period of 10 years. This person has been noted to have experienced allergies at least once each year. He is a smoker and has suffered from bronchial asthma since early childhood. Symptoms reported by the active employees suggest a possible mild overexposure to formaldehyde. The history of the retired embalming instructor should be interpreted in light of the reports on "occupational asthma." His thorough checkup, including complete pulmonary function testing and bronchial secretion cultures, did not reveal any other specific clues. Antibiotic treatment was ineffective. After removal from the laboratory, he improved rapidly and was back to normal after two weeks of no exposure.

V. RECOMMENDATIONS

1. Protective clothing should be provided for the embalming employees. Such clothing should include gloves made of impervious materials, protective aprons, leather or rubber safety shoes, and eye protection.

2. A ventilation consultant should be retained to evaluate the efficiency of the present exhaust system. An adequate system should eliminate the recirculation of air by incorporating a "once-through" air handling system. This involves resizing the refrigeration and heating elements. Removal of formaldehyde and other vapors can also be achieved by charcoal adsorption processes.

3. A formaldehyde meter with an audible alarm system should be installed in the embalming area. The alarm on the device should be set to sound when the 1.0 ppm level is reached. When the alarm sounds, respiratory protection such as a gas mask with an organic vapor canister or a chemical cartridge full facepiece respirator should be donned.

VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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VII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service, (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a) Director of Embalming Laboratory, Cincinnati College of Mortuary Science - 2220 Victory Parkway, Cincinnati, Ohio 45206.
b) U.S. Department of Labor, Region V
c. NIOSH, Region V

VIII. REFERENCES

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11. Hawley Gessner G., Condensed Chemical Dictionary, Van Nostrand Reinhold Co., New York, N.Y. 1001, 1977.

12. U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, Occupational Diseases - A Guide to Their Recognition, DHEW (NIOSH) Publication No. 77-181.

TABLE I

RESULTS OF SAMPLES COLLECTED
CINCINNATI COLLEGE OF MORTUARY SCIENCE
CINCINNATI, OHIO

September 11, 1979

Sample Number	Volume (liters)	Time	Location and Description of Area	Concentration - Parts Per Million (ppm) Phenol③	Formaldehyde④ (para)
IM-10	129.0 l	10:40 a.m.-12:06 p.m.	Personal conducting simulated embalming operations	N.D.①	N.A②
IM-12	130.0 l	10:42 a.m.-12:09 p.m.	Overhead between operating Table I and II	N.D.	N.A.
CT-2	16.2 l	10:45 a.m.-12:06 p.m.	Overhead between operating Table I and II	N.A.	0.51 ppm
CT-1	16.2 l	10:45 a.m.-12:06 p.m.	Personal conducting simulated embalming operations	N.A.	1.76 ppm
CT-3	16.4 l	10:46 a.m.-12:08 p.m.	At the foot of Table #II	N.A.	3.99 ppm
IM-24	120.0 l	10:50 a.m.-12:10 p.m.	At the foot of Table #II & III	N.D.	N.A.

① ND ---------- Non detectable

② NA ---------- Not Applicable

③ Phenol-------- OSHA (legal) standard 5 ppm. NIOSH recommended standard 5.2 ppm/15-minute ceiling 15.6.

④ Formaldehyde - OSHA (legal) standard 3 ppm TWA, ceiling 5 ppm. NIOSH recommending 1.0 ppm for a 30-minute ceiling.

TABLE II

RESULTS OF SAMPLES COLLECTED

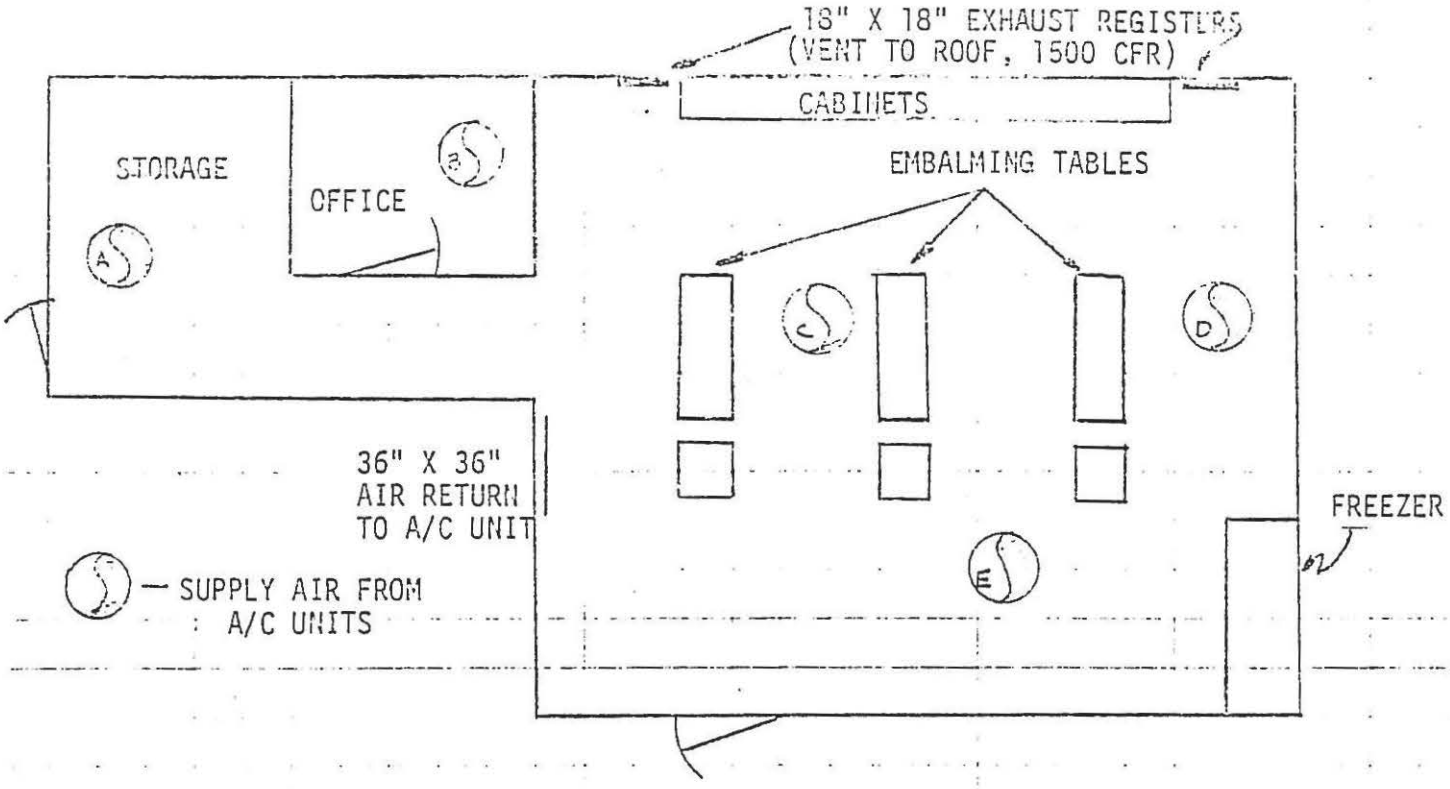
CINCINNATI COLLEGE OF MORTUARY SCIENCE
CINCINNATI, OHIO

January 22-23, 1980

Sample Number	Volume (liters)	Time	Location and/or Description of Sample	Parts Per Million parts of air (ppm) Formaldehyde Concentration		Date
M-1	35.3 l	12:20 p.m.-5:29 p.m.	Personal - student	3.93 ppm	Section A	01/22/80
M-2	62.6 l	12:22 p.m.-5:35 p.m.	Mortician - instructor	1.30 ppm		" "
M-3	58.3 l	12:27 p.m.-5:38 p.m.	Hanging from ceiling (head height)	3.65 ppm		" "
M-4	60.2 l	12:30 p.m.-5:31 p.m.	Office Adjacent Embalming Area	2.03 ppm		" "
M-5	52.5 l	12:55 p.m.-5:30 p.m.	Center of Embalming Area (table)	2.49 ppm		" "
M-6	44.8 l	12:56 p.m.-4:34 p.m.	Above worker's head - center of room	0.56 ppm	Section B	01/23/80
M-7	43.9 l	12:58 p.m.-4:28 p.m.	Office Adjacent Embalming Area	0.20 ppm		" "
M-8	47.3 l	12:57 p.m.-4:28 p.m.	Table - Center of Embalming Area	0.24 ppm		" "
M-9	34.0 l	12:58 p.m.-3:48 p.m.	Student (personal)	0.91 ppm		" "
M-10	25.6 l	12:58 p.m.-4:30 p.m.	Embalming instructor	0.67 ppm		" "

TABLE III

CCMS Laboratory 10-2-79



AIRFLOW: UNITS IN CUBIC FEET PER MINUTE (CFM)

LOCATION	DESIGN	ACTUAL
A	350	300
B	175	500
C	850	750
D	850	500
E	850	1100
TOTAL	3075	3150